

# Challenges of Corn Stover Transportation

## Introduction

- Stover has the potential to be a very useful byproduct of corn.
- Corn stover uses:
  - Feedstock for cellulosic ethanol
  - Fuel source for power plants
  - Animal bedding
- Benefits of corn stover::
  - Inexpensive
  - Readily available in Iowa



Figure 1. A corn field after harvest. Corn stover is shown (Purdue, 2015)

- Who can stover benefit?
  - Farmers who can make money by selling stover
  - Buyers have access to cheap, eco-friendly material (Purdue, 2015)

## Background Information

Previously:

- A few weeks after harvest, farmers rake stalks into windrows, allowing the baler to do fewer passes through the field. Transportation, was first tractor and wagon, and then to rail or truck. Now, the most common transport is directly to trucks/semi's, and then sometimes to rail cars. (Atchinson, 2004)

Current transportation:

- Truck-trailer: Allows for larger amounts to be hauled at once. Not the most convenient due to traffic.
- Semi-truck: One of the most common, allows large amounts to be shipped at a time. Also not as convenient from traffic.
- Tractor and Trailer/ wagon: Not used as often, mainly with smaller operations.
- Rail: most preferred, can carry large amounts and transfers intermodal is not necessary. (McGill, Darr)

\$ per acre	Livestock (round)	Biofuel (square)
Windrowing	\$10.45	\$13.91
Baling	\$23.31	\$17.86
Collecting bales	\$9.29	\$9.11
Hauling bales (25 miles)	\$19.00	\$25.00
Total cost per acre	\$62.05	\$65.88
Total per bale (4/acre)	\$15.51	\$16.47
Total cost per ton (.6t./ bale)	\$25.85	\$27.45

Table 1. shows the total costs for two stover harvesting options (Edwards, 2014)

## Constraints and Opportunities



Figure 2. Corn stover that has been baled (Hall, 2016)

- Several complications are tied to the transportation, storage, and processing of corn stover, namely:
  - high moisture content - 16%
  - Low density - (144-224 kg\*m<sup>-3</sup>)
  - Removal of potential nutrients

Notable Logistic Considerations:

- Plant proximity is important to minimize transportation costs and ensure the product is stored readily and properly so it is not affected by its high moisture content.
- A large storage facility would also be necessary to compensate the low density product that requires considerable storage volume.
- The average soil replacement rate of corn stover is 3.1 kg phosphate and 16.5 kg potash per Mg of removed stover. (Petrolia, 2008)

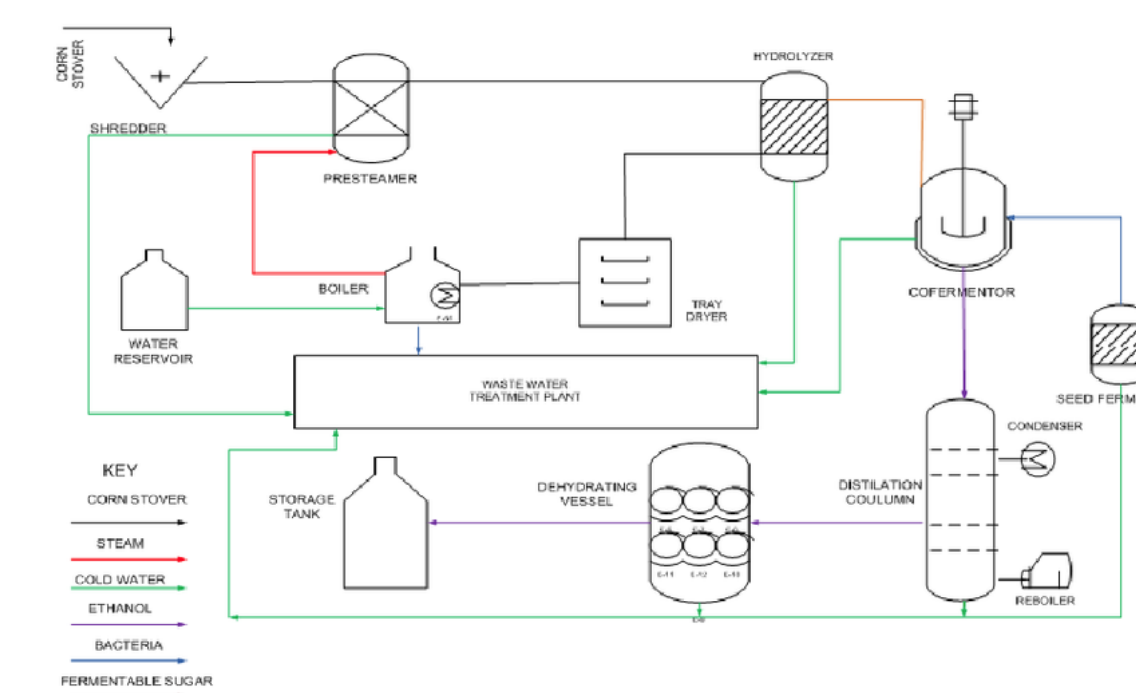


Figure 3. Process flow diagram for the production of cellulosic bio-ethanol from corn stover (Manyuchi, 2015)

## Potential Solutions

Bale Densification

- Has the potential to minimize many of the current costs associated with the transportation and storage of stover bales.
  - Densification increases the stover density to 625 kg\*m<sup>-3</sup>
  - Densification cost: \$25.72 / Mg
  - Allowing more stover to fit in less volume in storage and transportation (Petrolia, 2008)

Additional Densification Step

- Requires extra facility at regional storage sites.
- The low density bales would still have to be stored and transported to the densification facility.
- The transportation and storage at the conversion processing facility would be greatly decreased.

More Infrastructure

- A wider implementation of the densification process and facilities
  - Increase economic viability
  - More ergonomic logistical plan (Petrolia, 2008)

## References

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